Incentive Auction Band Plans and PN DA 13-1157

Prepared for the Competitive Carriers Association

June 14, 2013

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Incentive Auction Band Plans

- Public Notice Overview
- Discussion of Band Plan Proposals
- DTV in the Duplex Gap
- TDD Observations
- Common Ground

Overview of FCC Public Notice DA 13-1157 (1 of 2)

wireless strategy

- The FCC issued a PN requesting additional information on band plans for the broadcast Incentive Auction.
- The PN noted two goals for the Incentive Auction band plan:
  - Support varying amounts of spectrum by market (market variation)
  - Based on comments, the band plan should prioritize paired spectrum over unpaired spectrum (provide an uplink capability)
- The PN observed that many of the "Down from 51" band plans were less flexible in providing market variation:
  - Some plans require a large starting position to "open" a market (uplink block + duplex gap + downlink block + guard band)
  - Other plans suggested placing high- or low-power DTV in the uplink band to reduce the DTV channel count to open a market

Overview of FCC Public Notice DA 13-1157 (2 of 2)

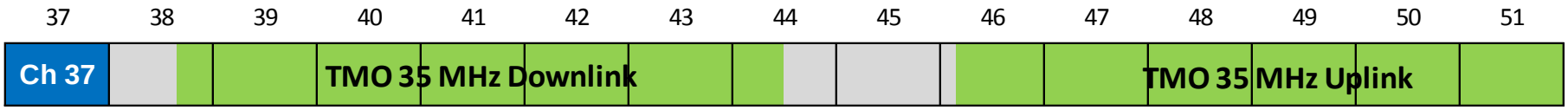
wireless strategy

- The PN observed that support for the "Down from 51" band plan is based on concerns of high-power DTV in the duplex gap, and antenna design issues.
- Finally, the PN requested additional comment on two alternative proposals, to complete the record and understand whether improvements to market variation are possible:
  - "Reverse Down from 51" consisting of a Channel 51 guard band, a new downlink adjacent to 51, duplex gap, and variable uplink with guard band
  - TDD band plan down from 51, with a guard band in Channel 51.

Key topics addressed herein are market variation, pros/cons of band plan proposals, and certain technical issues.

Band Plan Proposals:
“Down from 51”

“Down from 51” FDD Plan

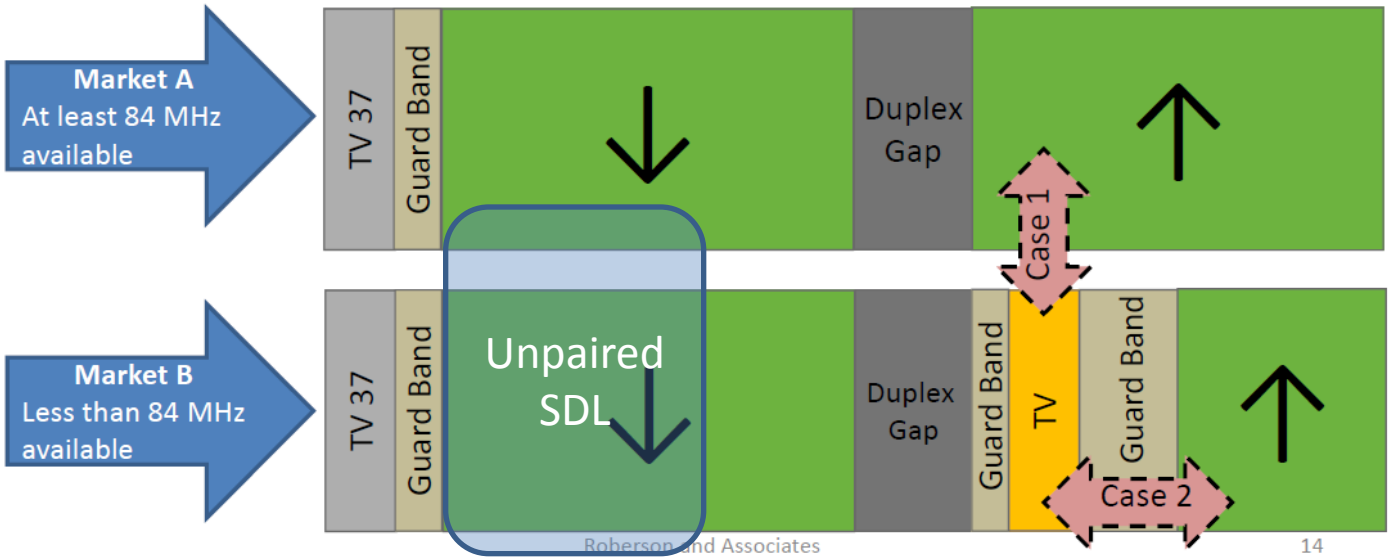


DTV Market with at least 14 Channels Cleared

- Using the T-Mobile plan as an example, many commenters have proposed FDD band plans going down from Channel 51, with both uplink and downlink above Channel 37.
- In markets where at least 14 DTV channels are cleared, the paired FDD spectrum would consist of 35 + 35 MHz.

DTV in the Uplink Band

- What happens when fewer than 14 channels are available?
- Per Roberson and Associates (April 17, 2013 study), DTV could be placed in the uplink band to reduce the minimum starting position in a market:

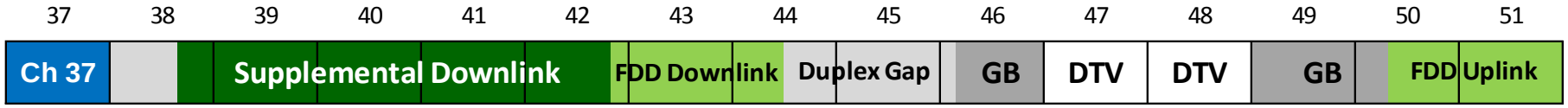


"Down from 51" with DTV in the Uplink

- Such an approach would introduce unpaired Supplemental Downlink channels above Channel 37 in the more spectrum-constrained markets.

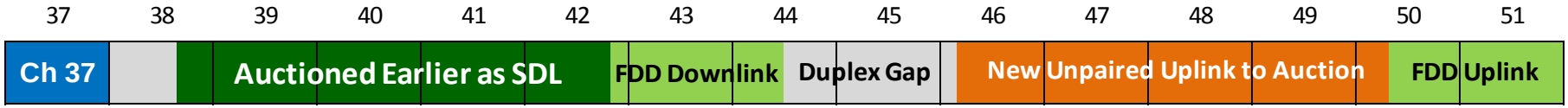
Supplemental Downlink Conundrum

- The portion of the downlink band not paired with uplink in a market is proposed to be auctioned as Supplemental Downlink:



FDD Market with 12 DTV Channels Cleared

- At a future time in this market, when two more DTV channels are cleared, the newly cleared uplink blocks are stranded:

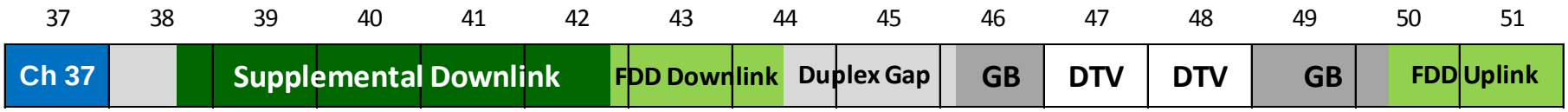


Same Market in Future with 14 DTV Channels Cleared

- The newly freed spectrum could be auctioned as unpaired uplink
- The entity which would profit most from this spectrum would be the owner of the corresponding SDL blocks.

SDL does not provide uplink capability in the near term and may threaten competitive access to uplink over the long term.

Auction Efficiency of "Down from 51" Plans with SDL

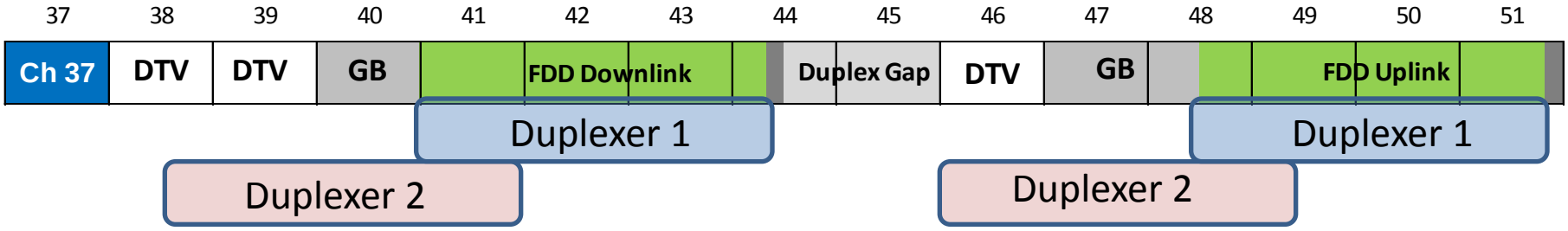


FDD Market with 12 DTV Channels Cleared

- When fewer than 14 DTV channels are cleared, considerably less spectrum is available for auction, particularly "uplink capable" spectrum:
  - 10 MHz of uplink-capable spectrum
  - 35 MHz of downlink spectrum
  - 17 MHz used for guard band
  - 10 MHz duplex gap
- Several DTV channels cleared in the market could not be used for broadband because of the need to provide dedicated spectrum for the duplex gap and guard bands.
- In terms of the amount of spectrum available for auction, this market delivered 53.6% of the cleared spectrum for broadband use.

Multi-Duplexer Approach to "Down from 51"

- A technical approach employing multiple duplexers could provide additional paired spectrum in low-clearance markets:

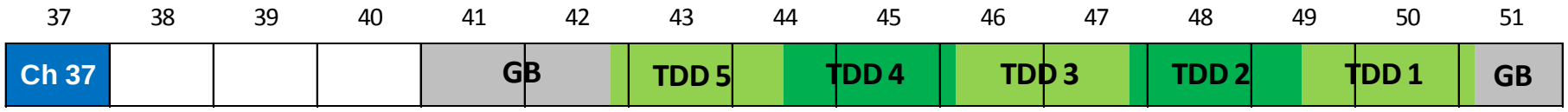


FDD Plan with at least 11 DTV Channels Cleared

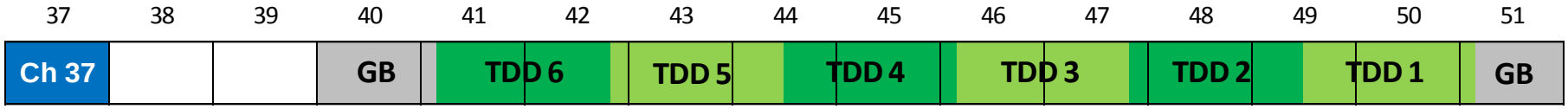
- A few tweaks to the plan would improve auction efficiency:
  - Shift the broadband blocks and duplex gap down by 1 MHz to align the upper edge of the duplex gap with Channel 46.
  - Permits placement of DTV in Ch 46, adjacent to the duplex gap, eliminating the second uplink guard band.
  - Rely on the dual-duplexer approach to provide filter attenuation of DTV channels below the uplink/downlink blocks.
- Provides a means to "open" a market with 11 DTV channels cleared, delivering 20+20 MHz of paired spectrum, with 60.6% auction efficiency.
- Future clearance and auction would deliver an additional 15+15 MHz of paired spectrum, already supported by legacy devices.

Proposed Band Plans: TDD

TDD Plans



TDD Market with 11 DTV Channels Cleared (75% Auction Efficiency)

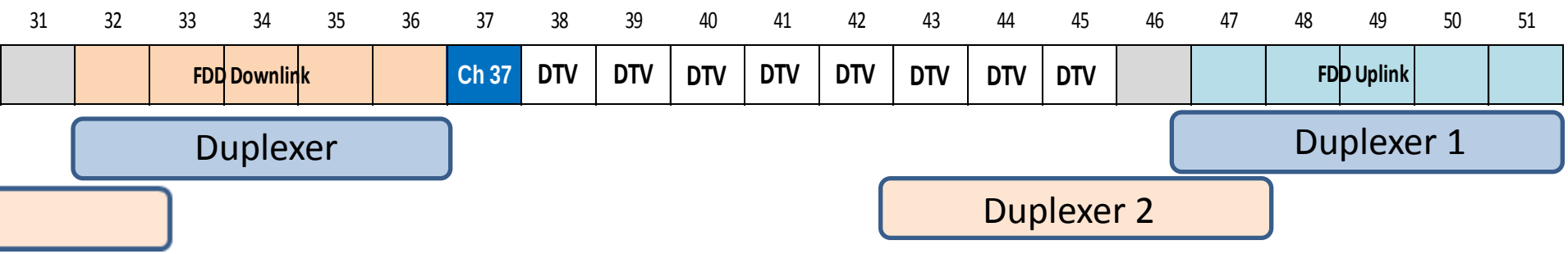


TDD Market with 12 DTV Channels Cleared (83% Auction Efficiency)

- TDD does not require a duplex gap, but requires guard band on each side of the TDD band to protect to/from DTV and 700 MHz operations.
- Necessary size of guard band is a consideration not examined here; efficiencies above may change following guard band analysis.
- Initial comparison suggests that TDD is efficient in terms of market variation.

Proposed Band Plans: NPRM FDD Plan

NPRM FDD Plan



Original NPRM FDD Plan with 12 DTV Chs (83% Auction Efficiency)

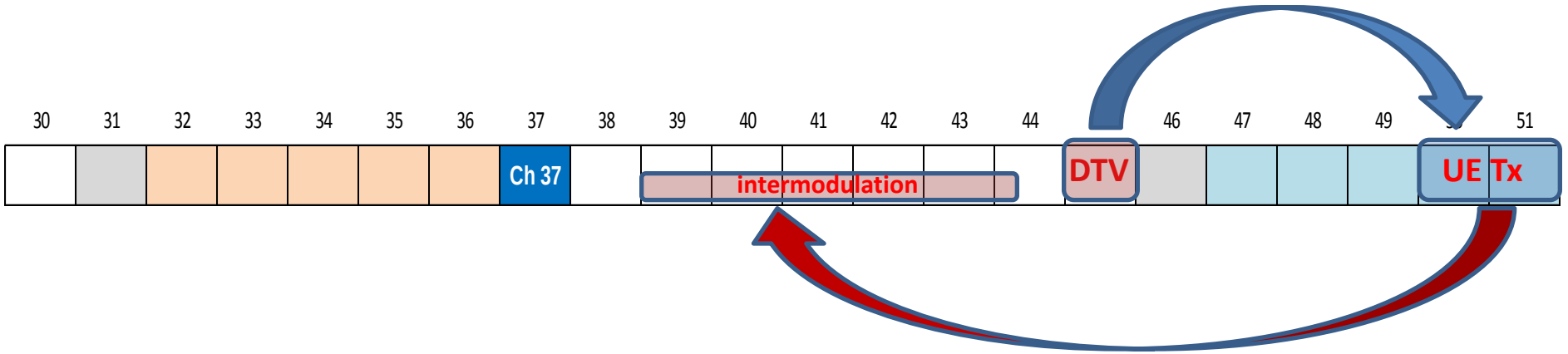
- Achieves 30+30 MHz of paired spectrum.
- Leverages Channel 37 for filter rolloff on the downlink side.
- If 30 MHz filters are used, then the minimum "starting position" could be 12 DTV channels cleared.
- A dual-duplexer approach would be needed for markets with more than 12 DTV channels cleared.
- Smaller duplexer passband sizes may facilitate a smaller "starting position" but with the tradeoff of more duplexers in the device.

NPRM FDD Plan opens more paired blocks than "Down from 51"

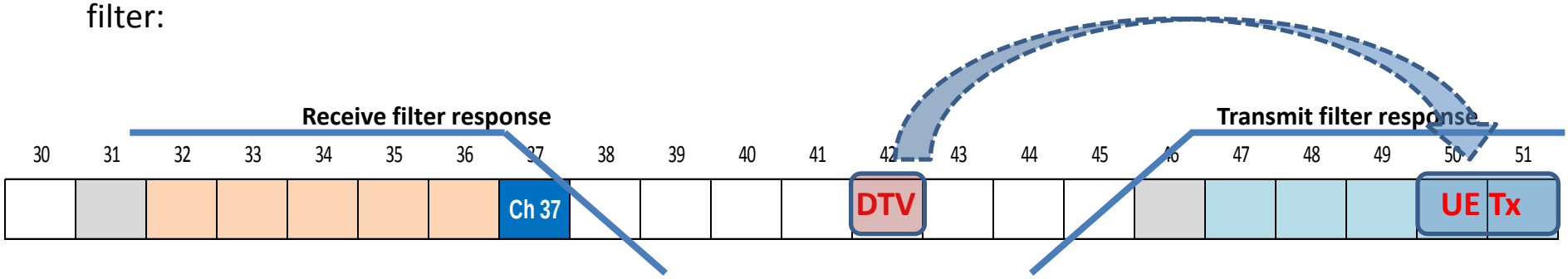
DTV in the Duplex Gap

Intermodulation Interference is Not a Threat

- Some commenters have expressed concern about DTV operation “in the duplex gap”, suggesting that intermodulation may cause interference.
- Any intermodulation caused by a DTV channel close to the uplink band will not fall within the device receive band, but rather in the intervening DTV channels (at very low power levels at a DTV receiver:



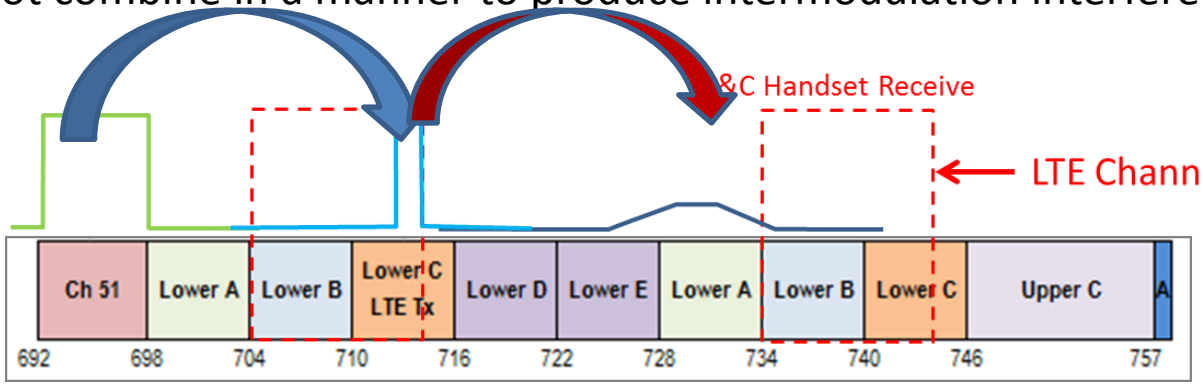
- DTV channels farther away from the uplink band would be significantly attenuated by the duplexer filter:



- The filter attenuation in this case is more than adequate to reduce the DTV power to manageable levels.

DTV IM Case is Identical to Lower 700 MHz

- AT&T is operating numerous 700 MHz LTE systems in markets with full-power DTV Channel 51 stations.
- AT&T's device transmit band has 6 MHz of frequency separation from DTV 51, identical to the frequency separation recommended by some commenters in the Incentive Auction proceeding.
- AT&T has made no claims regarding Band 17 device interference from Channel 51.
- As evidenced by the Hyslop-Kolodzy and V-Comm test reports in the 700 MHz Interoperability proceeding, intermodulation interference will not occur in a commercial LTE market, even for Band 12 devices with no significant filtering of the DTV signal.
- Commercial LTE device performance and ground-level DTV signal strength simply do not combine in a manner to produce intermodulation interference.



ATT Deployed Network

TDD Observations

TDD Analysis

- Proposals for TDD should have technical bounds managing some of the coexistence concerns.
- Explicit rules would remove marketplace uncertainty among licensees and speed time-to-market.

TDD Advantages	TDD Disadvantages	Technical Bounds
Traffic asymmetry provides flexible DL throughput.	Different operators must coordinate TDD asymmetry.	Define a TDD split as an auction default. All licensees in a market must concur to change the default.
TDD antenna efficiency is better through small bandwidth requirement.		
	Inter-system radio frame timing coordination is required.	Require licensees to synch to GPS and employ radio frame-harmonized technologies.
TDD provides flexibility in market variation.		

Common Ground

Common Ground

- Regardless of band plan:
  - Blocks for auction should contain an uplink capability to provide coverage enhancement for competitive carriers.
  - FCC should define a minimum “starting position” of DTV channels cleared, tailored to the adopted band plan and technology capabilities.
  - Beyond the minimum, the adopted band plan will have a “staircase” of DTV channels cleared which feed the next supported increment of the band plan (e.g., if 12 DTV channels cleared is the starting point, the next step on the stair might be 16 DTV channels cleared).
- “Down from 51” FDD Band Plans:
  - The adopted band plan should not permit supplemental downlink allocations above Channel 37 to prevent stranding future cleared blocks.
  - The Commission should consider a dual-duplexer approach as a technical solution permitting a lower “starting position”.
- TDD Plans:
  - If the Commission determine that operators are unlikely to reasonably agree on 3GPP-specified asymmetry ratios in a timely manner, it should consider defining a default TDD asymmetry ratio and radio frame timing approach to manage inter-system interference.